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Percutaneous sentinel node removal using a vacuum-assisted needle biopsy in women with breast cancer: a feasibility and acceptability study

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Abstract

Aims: to assess the feasibility and acceptability of large-gauge percutaneous removal of the axillary sentinel lymph node (SLN) using dual gamma probe and ultrasound guidance.

Materials and Methods: Technetium nanocolloid was administered the day before surgery. On the day of surgery, potential SLNs were identified with gamma probe and ultrasound scanning. A 7G vacuum assisted biopsy (VAB) device was inserted percutaneously deep to the target node and the node(s) removed. The gamma probe was used to confirm removal of radiolabelled tissue.

At surgery, any residual radiolabelled or blue nodes were removed. Morbidity was assessed via (i) a pain questionnaire immediately after the percutaneous procedure, (ii) relevant items from the FACT B+4 questionnaire 7-10 days after surgery, and (iii) case note review one month after surgery.

Results: Twenty-two patients consented and 20 patients underwent the procedure. Radiolabelled nodal tissue was obtained in 18/20 (90%). The mean procedure time was 11 minutes. Four of 18 patients had metastatic disease identified in the VAB excision tissue with 100% sensitivity for axillary metastasis. At axillary surgery, additional intact SLN or fragments were found in 14 patients. No additional metastatic disease was found at surgery. One patient suffered a pneumothorax during instillation of local anaesthetic. The median pain score was 10/100 by visual analogue scale. Immediate post procedure haematoma was common (14 of 20) and prolonged manual compression frequent.

Conclusion: VAB removal of sentinel nodes using dual scanning is feasible. Although preliminary sensitivity and specificity levels are encouraging, complications may discourage widespread implementation.

Introduction

Sentinel lymph node biopsy (SNB) is the current standard of care for staging the axilla in breast cancer patients in whom axillary lymph node metastasis has not been diagnosed preoperatively. SNB results in less morbidity than lymph node dissection (ALND), but SNB does have some associated morbidity. Seroma incidence after SNB is 14%, while limited shoulder mobility, paraesthesia and loss of sensation are not uncommon [1]. A long-term study of patients after SNB found frequencies of chronic lymphoedema and paraesthesia of 5.4% and 10.8% respectively { ADDIN EN.CITE { ADDIN EN.CITE.DATA }}. Therefore, further improvements in axillary management for patients with early breast cancer are required.

Pre-operative detection of axillary lymph node metastasis by ultrasound and core biopsy of abnormal nodes diagnoses approximately 50% of positive axillae [3]. The poor sensitivity of axillary ultrasound and biopsy is caused by failure to sample the sentinel lymph node and/or the site of metastasis of an involved node [4, 5]{{}. If normal-appearing SLNs could be accurately targeted and removed percutaneously, the management of some breast cancer patients could be streamlined.

Little evidence exists evaluating the use of dual scanning with a hand-held gamma probe and ultrasound to detect the SLN following injection of technetium-99 labelled nanocolloid. A study published in 2001 aimed to diagnose axillary metastases using a gamma probe and ultrasound-guided FNA. The investigators identified the SLN in only 29 of 92 (32%) patients [6].

However, ultrasound technology has improved markedly in recent years, and specialist breast radiologists are now more experienced in axillary ultrasound and needle biopsy. In one study using current technology, a SLN was correctly identified and wire-localised using gamma-probe guided ultrasonography in 44 of 59 patients (75%; 95% CI: 63-86%). There were no serious adverse events [7].

A recent study of vacuum assisted biopsy (VAB) of the sentinel node in breast cancer patients used microbubble contrast agent to identify the SNB, and a small (13G) vacuum device. The sensitivity for metastatic disease was moderate (59%) and complications made subsequent axillary surgery difficult [8]. Another randomised study of vacuum biopsy vs core biopsy of sonographically abnormal axillary nodes (not necessarily the sentinel node) reported similar sensitivities for both procedures (78% and 79%) but again this study used a small bore (13G) device [9]. Both studies aimed to sample the node rather than remove it.

Our aim was to examine the feasibility and acceptability of large-gauge (7G) percutaneous removal of the SLN using dual gamma probe and ultrasound guidance in 20 patients.

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Patients and methods

This prospective, non-therapeutic, single-arm trial was conducted at a single breast unit. National Health Service Research Ethics Committee and local management approvals were obtained. Women with primary, operable, invasive breast cancer scheduled for surgical sentinel lymph node biopsy (SNB) were eligible to participate in the study, subject to written informed consent.

Participants had to be aged 18 or over and able to consent for themselves. Patients who had had neoadjuvant chemotherapy or previous axillary surgery were excluded. Eligible patients were consecutively approached, except where logistical barriers precluded recruitment.

Standard institutional SNB practice during the study period was a peri-areolar intradermal breast injection of 40 MBq of technetium-99 nanocolloid (Solco Nanocoll®; Nycomed, Amersham, UK), administered in the early afternoon of the day prior to surgery. Lymphoscintigraphy was not performed. Throughout recruitment, it was also standard practice to inject 1–2 ml blue dye (Patent Blue V®; Guerbet, Paris, France), in the peri-areolar region once the patient was anaesthetised.

On the morning of surgery, patients attended the breast imaging department where a gamma probe (Dilon Navigator; Dilon Technologies Inc., Newport News, VA, USA) was used over the skin of the axilla to identify any radioactive “hot” spot which could represent a SLN. Ultrasound scanning (Aixplorer Multiwave unit with 4-15 MHz SuperLinear™ transducer; SuperSonic Imagine, Aix-en-Provence, France), guided by the hot spot, was then used to visualise potential SLNs. Once a possible SLN was detected, 10-15mls of 2% lidocaine with adrenaline (1:200,000) was administered, a 7G vacuum assisted biopsy device was inserted deep to the target node under ultrasound guidance, and the node was removed. The gamma probe was placed over the retrieval basket to confirm the removal of radiolabelled tissue. If there was little apparent bleeding and the patient was comfortable, further hot nodes were sought, and up to three nodes in total were removed. The study procedures were all performed by one operator, a highly experienced breast radiologist. This was because we wished to reduce the impact of any learning curve for the technique on the results.

Participants were asked to complete a pain questionnaire at the end of the procedure, consisting of a 0-100 visual analogue scale (VAS) and a four-point verbal pain rating scale (none, mild, moderate, severe).

The patients then proceeded to the operating room the same day, where the axilla was explored according to standard practice, and any residual hot or blue nodes were removed. The surgeon also documented the presence of any partially resected hot or blue nodes and the presence and size of any haematoma.

When the patients returned to hospital for review at 7-10 days postoperatively, they completed a subset of items from the FACT B+4 questionnaire [10], assessing arm movement, pain, and sensation. Nursing and medical notes were examined one month after surgery to ascertain the presence of any axillary post-operative complications.

Results

Twenty-two patients consented to enter the study; two were withdrawn as no hot spot could be identified at dual scanning. Both these patients had one hot node detected at surgery. The mean age was 60 (range 44 to 80). Radiolabelled nodal tissue was obtained in 18/20 (90%): 14 patients had one node removed, five patients had two nodes removed and one patient had three nodes removed. The mean procedure time was 11 minutes (range 3-23 minutes). Among the 20 patients, subsequent surgery yielded six without hot or blue nodes, two had no hot nodes but had blue nodes, five had hot and blue nodes and seven had hot but not blue nodes.

One serious adverse incident occurred when a pneumothorax was caused during instillation of local anaesthetic prior to VAB, this became apparent after the VAB and required chest drain insertion.

There were 19 complete pain datasets (excluding the patient who suffered a pneumothorax). The median VAS pain score was 10 (range 0-56) and the pain from the procedure was described as none by seven participants, mild by eight, moderate by four and severe by none.

Immediate post procedure bleeding and haematoma formation were common (14 of 20) and manual compression of the site for 15-30 minutes was required. The other immediate symptom reported by patients was arm paraesthesia, generally attributed by the patients to the arm position. Three commented on the unpleasantness of the pressure applied to reduce haematoma.

Post-procedure haematoma was identified at surgery in 15 patients (75%). Four patients had metastatic disease identified in the nodal tissue removed at VAB excision. No metastatic disease was found in these or other patients in the tissue resected at surgery. The sensitivity of the VAB excision was therefore 4/4 (100%).

All 20 patients completed the arm morbidity item subset of the FACT B+4 questionnaire 7-10 days after surgery (Table 1). The commonest symptom was painful shoulder movement (9 patients; 45%), while the only symptom with the highest severity rating was arm numbness (3 patients; 15%). No

significant axillary complications were identified at review of the clinical and nursing notes one month after the procedure.

Discussion

Large-gauge VAB removal of sentinel nodes using dual scanning with a gamma probe and ultrasound is feasible in early breast cancer patients. The sensitivity performance of VAB for the detection of nodal metastatic disease in this study is very limited (100%, 4/4) but is encouraging, and reflects the intent to remove the node entirely by the use of a large-gauge needle. Prior studies used smaller gauge needles, aiming to sample rather than remove the node [8,9].

In the present study, the large gauge allowed removal of individual nodes with as few as four needle cores. Minimising the number of passes was intended to minimise haematoma formation, and to aid subsequent distinction between residual nodal cortex and peri-nodal haematoma during ultrasound.

Given that a whole node or the vast majority of a sentinel node is removed with this technique its ability to differentiate micro-metastatic from macro-metastatic should be similar to conventional SLNB.

One of the benefits of using the gamma probe is that it is possible to confirm immediately the removal of hot tissue by placing the gamma probe on the retrieval basket of the VAB probe. This was particularly useful when two nodes were close together and where dual *in vivo* scanning could not resolve which node was hot. If one node was removed and shown to be cold, the other node could be removed without delay as long as haemostasis and patient comfort allowed.

If VAB excision of SLNs could be performed accurately and safely it might be particularly useful in those patients who currently undergo surgical SNB as a separate procedure, often prior to breast reconstruction.

The major obstacle to the use of the study technique is the high frequency of haematoma at the biopsy site, which often required prolonged compression in the radiology unit and which may have

made subsequent surgical assessment of the axilla difficult in some cases. This issue was also apparent in the two previous studies of VAB using smaller gauge needles in the axilla [8,9]. It is difficult to see how the haemostasis problem can be overcome without the development of a percutaneous coagulation device.

There was also a tendency for the blue dye to collect as a pool in the biopsy cavity. This may have impeded the flow of the blue dye to more distal nodes, but does serve to suggest that the first sentinel node had indeed been excised by VAB under image guidance.

Future applications of this technique might consider the use of alternative dyes administered prior to VAB such as the Siena ferric-based technique successfully compared with blue dye in conventional dual technique sentinel lymph node biopsy [11]. Use of that technique could also facilitate node detection using the relevant iron detecting probe as an additional method to identify axillary sentinel nodes for VAB.

The serious adverse event of a pneumothorax requiring chest drain insertion was caused during instillation of local anaesthetic, not by VAB excision itself. For the study procedure, unlike during 14G core biopsy of an axillary node, local anaesthetic needs to be injected deep to the node to allow ultrasound visualisation of the structure during removal. Puncture of the chest wall is therefore more likely when instilling local anaesthetic for an axillary VAB than for a core biopsy, particularly in a slim individual as was the case here. We consider it unlikely that pneumothorax would be a common complication of axillary VAB.

The median VAS pain score for the procedure was perhaps surprisingly low at 10, and was similar to the figure of 13 reported for localisation wire placement in the axilla [7]. The post-operative questionnaire showed high levels of short-term (7-10 days) post-operative morbidity. We did not have a comparison group of women undergoing solely surgical SNB complete the same questionnaire during the same time period. However, the morbidity identified after VAB node removal was higher than that found for comparable patients in the ALMANAC study one month after

surgery [12]. It is therefore likely that the percutaneous SLN removal resulted in increased short-term morbidity, although any long-term consequences are not known. Knowledge of long term morbidity would be crucial before a possible role for this technique could be formulated, especially as there is a trend for a more conservative approach to the positive but low volume axilla.

The main limitations of this single arm study are the small sample size, particularly the very small number of node-positive patients, and the lack of a randomised control group to compare morbidities. The procedures were carried out by one experienced radiologist at a single site so the generalisability of the results is not known. It is our view that a practitioner performing this technique needs to be experienced at US guided VAB excisions in the breast and US guided axillary core biopsy before commencing.

Most studies of percutaneous SLN sampling have used ultrasound microbubble contrast agents to identify the SLN. The microbubble technique has the advantages of not using radiation and being able to identify the first-draining node or nodes in real time. Disadvantages include the very transient nature of the nodal enhancement, which means that repeat injections are sometimes required, and the inability to confirm removal of labelled material. The success rate using microbubbles to identify the SLN appears highly operator dependent, as subsequent studies have not been able to replicate the very high identification rates initially observed [8, 13, 14].

We elected to use dual scanning with ultrasound and the gamma probe as a potentially more generalizable approach, as both modalities are readily available in current breast cancer practice. The disadvantages of dual scanning are that the patient requires a technetium injection some time prior to the procedure, and that the relatively poor spatial resolution means that it can be impossible to know which node is hot when 2 or more nodes are close together. In this context, the ability to test the resected tissue for radioactivity is extremely useful. As an alternative or addition, visual assessment facilitated by use of brown, ferrous dye merits further consideration [11].

Conclusions

We have demonstrated that VAB removal of sentinel nodes under local anaesthesia using combined ultrasound and gamma scanning is feasible, with potentially high sensitivity for metastases.

However, the technical challenges and the levels of morbidity observed in our study suggest that further development of the technique may be required before more widespread evaluation or implementation is considered.

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Score (0=not at all, 4=very much)	0	1	2	3	4
Painful arm movement n(%)	11(55)	4(20)	4(20)	1(5)	0
Poor range of movement n(%)	15(75)	3(15)	1(5)	1(5)	0
Arm numbness n(%)	13(65)	3(15)	1(5)	0	3(15)
Arm stiffness n(%)	12(60)	6(30)	2(10)	0	0

1 **Table1: Postoperative morbidity assessed by patient questionnaire**